

WHAT IS CLAIMED IS:

1. A color combining optical system, which combines a first color light and a second color light, comprising:

5 a polarization color combining film made of a multilayer film;

wherein the polarization color combining film combines a first polarization component of the first color light and a second polarization component of the second color light, which
10 has a polarization direction substantially perpendicular to the first polarization component, with an efficiency of 90% or more in a predetermined incidence angle range.

2. The color combining optical system according to claim 1,

15 wherein the predetermined incidence angle range is a range of a reference incidence angle $\pm 5^\circ$ with respect to the polarization color combining film.

3. The color combining optical system according to claim 1,

20 wherein the color combining optical system combines the first color light and the second color light, respectively coming from a first and a second image forming element forming an original image, and guides the combined light to a projection optical system;

25 wherein the color combining optical system further comprises a first and a second analyzing member; and

wherein the first color light is guided via the first

analyzing member and the polarization color combining film to the projection optical system, and the second color light is guided via the second analyzing member and the polarization color combining film to the projection optical system.

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4. The color combining optical system according to claim 1, wherein the first color light is light of a green wavelength range and the second color light is light of a red and blue wavelength range.

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5. The color combining optical system according to claim 1, wherein the color combining optical system combines the first color light and the second color light, respectively coming from a first and a second image forming element forming an original image, with a third color light from a third image forming element forming an original image, and guides the combined light to a projection optical system;

wherein the color combining optical system further comprises a first and a second analyzing member; and

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wherein the first color light is guided via the first analyzing member and the polarization color combining film to the projection optical system, and the second color light and the third color light is guided via the second analyzing member and the polarization color combining film to the projection optical system.

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6. The color combining optical system according to claim 5,

wherein the second analyzing member is a polarization beam splitter; and

wherein a color-selective wave plate is provided between the polarization beam splitter and the polarization color
5 combining film.

7. The color combining optical system according to claim 5,
wherein the first analyzing member comprises a first polarization beam splitter and a first polarizing plate, and
10 the second analyzing member comprises a second polarization beam splitter;

wherein a color-selective wave plate is provided between the second polarization beam splitter and the polarization color combining film, and a second polarizing plate is provided
15 between the color-selective wave plate and the polarization color combining film.

8. The color combining optical system according to claim 7,
wherein the first polarization beam splitter and the
20 second polarization beam splitter are comprised of polarization splitting films which have the same characteristics.

9. The color combining optical system according to claim 5,
wherein the first color light is light of a first
25 wavelength region of 500 to 570 nm, the second color light is light of a second wavelength region of 430 to 480 nm, and the third color light is light of a third wavelength region of 590

to 650 nm.

10. The color combining optical system according to claim 9,
wherein, when an incidence angle of the light incident
5 on the polarization color combining film is $45^\circ \pm 5^\circ$, then a
transmittance of the polarization color combining film in the
first wavelength region is 90% or more and a reflectance of the
polarization color combining film in the second wavelength
region and the third wavelength region is 90% or more.

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11. The color combining optical system according to claim 10,
wherein the polarization color combining film transmits
65% or more of P-polarized light and reflects 65% or more of
S-polarized light, which are in the visible wavelength region
15 and incident in the predetermined incidence angle region, and
the following conditions are satisfied:

$$R_{p1}/R_{p2} < 0.5$$

$$R_{p1}/R_{p3} < 0.5$$

where R_{p1} is an average reflectance for P-polarized light in
20 the first wavelength region, R_{p2} is an average reflectance for
P-polarized light in the second wavelength region, and R_{p3} is
an average reflectance for P-polarized light in the third
wavelength region, and

$$T_{s2}/T_{s1} < 0.5$$

25 $T_{s3}/T_{s1} < 0.5$

where T_{s1} is an average transmittance for S-polarized light in
the first wavelength region, T_{s2} is an average transmittance

for S-polarized light in the second wavelength region, and Ts3 is an average transmittance for S-polarized light in the third wavelength region.

- 5 12. The color combining optical system according to claim 11, wherein the polarization color combining film transmits 75% or more of P-polarized light which is in the visible wavelength region and incident in the predetermined incidence angle region.

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13. The color combining optical system according to claim 11, wherein the polarization color combining film reflects 75% or more of the S-polarized light which is the visible wavelength region and incident in the predetermined incidence
15 angle region.

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14. The color combining optical system according to claim 9, wherein, when the incidence angle of the light incident on the polarization color combining film is $45^{\circ} \pm 5^{\circ}$, then a
20 reflectance of the polarization color combining film in the first wavelength region is 90% or more and a transmittance of the polarization color combining film in the second wavelength region and the third wavelength region is 90% or more.

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- 25 15. The color combining optical system according to claim 14, wherein the polarization color combining film transmits 65% or more of P-polarized light and reflects 65% or more of

S-polarized light, which are incident in the predetermined incidence angle region, and the following conditions are satisfied:

$$Rp2/Rp1 < 0.5$$

5 $Rp3/Rp1 < 0.5$

where $Rp1$ is an average reflectance for P-polarized light in the first wavelength region, $Rp2$ is an average reflectance for P-polarized light in the second wavelength region, and $Rp3$ is an average reflectance for P-polarized light in the third
10 wavelength region, and

$$Ts1/Ts2 < 0.5$$

$$Ts1/Ts3 < 0.5$$

where $Ts1$ is an average transmittance for S-polarized light in the first wavelength region, $Ts2$ is an average transmittance
15 for S-polarized light in the second wavelength region, and $Ts3$ is an average transmittance for S-polarized light in the third wavelength region.

16. The color combining optical system according to claim 15,
20 wherein the polarization color combining film transmits 75% or more of P-polarized light which is in the visible wavelength region and incident in the predetermined incidence angle region.

25 17. The color combining optical system according to claim 15,
wherein the polarization color combining film reflects 75% or more of S-polarized light which is in the visible

wavelength region and incident in the predetermined incidence angle region.

18. An image projection apparatus, comprising:

5 a light source;

a color separating optical system which separates light from the light source into at least a first color light and a second color light;

at least two image forming elements;

10 a color combining optical system according to claim 1, which combines the first color light and the second color light from the image forming elements; and

a projection optical system which projects light combined by the color combining optical system.

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19. The image projection apparatus according to claim 18, wherein the image forming elements are reflective image forming elements.

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